

WHAT IS CLAIMED IS:

1. A two-dimensional code comprising:

a plurality of unit cells arranged in two-dimension, each of said  
5 unit cells indicating one of at least three colors, each color of each of said  
unit cells being optically readable and representing a data value set to  
each of the unit cells; and

a specifying pattern portion including a plurality of color reference  
cells and configured to specify positions of the unit cells, said color  
10 reference cells indicating all of the at least three colors.

2. A two-dimensional code according to claim 1, wherein said  
unit cells and color reference cells are arranged substantially in a matrix  
configuration, said plurality of color reference cells include first color  
15 reference cells, said specifying pattern portion includes a first specifying  
pattern that includes the first color reference cells, said first specifying  
pattern is disposed to one of peripheries of the matrix configuration, said  
at least three colors include a first color and a second color having a  
predetermined contrast level to be optically identifiable between each  
20 other, said first and second colors are individually assigned to the first  
color reference cells in accordance with a predetermined ratio between the  
first color and second color, and said predetermined ratio is optically  
readable independent of reading directions along the two-dimension.

25 3. A two-dimensional code according to claim 2, wherein said  
plurality of color reference cells include second color reference cells, third

color reference cells, fourth color reference cells, and fifth color reference cells, said specifying pattern portion includes second, third, fourth, and fifth specifying patterns, at least one of said second, third, fourth, and fifth specifying patterns is disposed to other one of the peripheries of the matrix configuration, said at least three colors include third, forth, and fifth colors which are different from the first and second colors, said third color is assigned to at least one of the second color reference cells, said fourth color is assigned to at least one of the third color reference cells, and said fifth color is assigned to at least one of the fourth color reference cells.

4. A two-dimensional code according to claim 2, wherein said first color is white and said second color is black.

5. A two-dimensional code according to claim 3, wherein said third, fourth, and fifth colors are red, blue, and green, respectively.

6. A two-dimensional code according to claim 3, wherein said first color reference cells, second color reference cells, third color reference cells, fourth color reference cells, and fifth color reference cells are disposed to four corner portions and a center portion of the matrix configuration, respectively.

7. A two-dimensional information code comprising:  
a plurality of blocks each including a plurality of unit cells, said plurality of blocks being arranged in two-dimension, each of said unit cells

indicating one of at least three colors, said at least three colors being optically readable, a combination of said colors assigned to each block representing data; and

5 a specifying pattern portion including a plurality of color reference cells arranged among the plurality of blocks, said specifying pattern portion specifying positions of the unit cells of each of the blocks, said color reference cells indicating all of the at least three colors.

8. A two-dimensional information code according to claim 7,  
10 wherein said each color of each of said unit cells represents one bit data, said one bit data takes one of a plurality of data values, and a number of data values corresponds to that of the at least three colors.

9. A two-dimensional information code according to claim 8,  
15 wherein said data represented by the combination of colors of each of the blocks is shifted by a constant data value so that the colors of adjacent unit cells of each of the blocks are different from each other.

10. A two-dimensional information code according to claim 7,  
20 wherein said plurality of blocks include at least one data block representing the data, and at least one error correcting block including an error correcting code for correcting an error caused in the at least one data block.

25 11. A two-dimensional information code according to claim 7, wherein said data of each of the blocks includes a data item that

corresponds to the combination of the colors assigned to each of the blocks, and an error detection code for detecting an error caused in the data item of each of the blocks.

5           12. A two-dimensional information code according to claim 11, wherein said data item and the error detection code represent a numerical value, and said combination of the colors assigned to each of the blocks represents the numerical value.

10           13. A generating apparatus for generating a two-dimensional code for representing data values, in which said two-dimensional code comprising a plurality of unit cells, said generating apparatus comprising:

          a controller; and

          a memory connected thereto and having a two-dimensional  
15 storage area, said controller being configured to:

          assign one of at least three colors to each of the unit cells, each color of each of said unit cells being optically readable and representing each of the data values;

          arrange the plurality of unit cells on the two-dimensional storage  
20 area in two-dimension; and

          allocate a specifying pattern portion on the two-dimensional storage area at a position adjacent to the unit cells so as to generate the two-dimensional code on the two-dimensional storage area, said specifying pattern including a plurality of color reference cells and  
25 configured to specify positions of the unit cells, said color reference cells indicating all of the at least three colors.

14. A generating apparatus for generating a two-dimensional code for representing data, said two-dimensional code comprising a plurality of blocks each including a plurality of unit cells, said generating  
5 apparatus comprising:
- a controller; and
  - a memory connected thereto and having a two-dimensional storage area, said controller being configured to:
    - divide the data into a plurality of pieces of data, said pieces of data  
10 corresponding to the blocks, respectively;
    - compute a data value of each of the pieces of data;
    - assign one of at least three colors to each of the unit cells of each of the blocks, each color of each of said unit cells being optically readable, a combination of said colors assigned to each of the blocks representing  
15 each of the computed data values;
    - arrange the colored blocks on the two-dimensional storage area in two-dimension; and
    - allocate a specifying pattern portion on the two-dimensional storage area at a position adjacent to the blocks so as to generate the  
20 two-dimensional code on the two-dimensional storage area, said specifying pattern including a plurality of color reference cells and configured to specify positions of the unit cells, said color reference cells indicating all of the at least three colors.
- 25 15. A generating apparatus according to claim 14, wherein said computing includes:

firstly computing error correcting codes according to the pieces of data, said pieces of data and error correcting codes constituting block data;

secondly computing an error detecting code according to each of the block data to add each error detecting code to each block data; and

thirdly computing each data value corresponding to each block data according to each block data.

16. A generating apparatus according to claim 15, wherein said thirdly computing includes adding a constant value to each block data to generate the data value of each block data so that the colors assigned to adjacent unit cells of each of the blocks are different from each other.

17. A reading apparatus for reading a two-dimensional code, in which said two-dimensional code comprising:

a plurality of unit cells arranged in two-dimension, each of said unit cells indicating one of at least three colors, each color of each of said unit cells being optically readable and representing a data value set to each of the unit cells; and

a specifying pattern portion including a plurality of color reference cells and configured to specify positions of the unit cells, said color reference cells indicating all of the at least three colors, said at least three colors having predetermined brightness levels to be optically identifiable thereamong, said reading apparatus comprising:

a reading unit configured to read out the two-dimensional code to generate at least three color image data corresponding to the at least three

colors;

a generating unit configured to generate brightness image data according to the at least three color image data, said brightness image data comprising at least two gray levels, one of which is higher than other  
5 thereof;

a detecting unit configured to detect the specified pattern portion according to the at least two gray levels included in the generated brightness image data;

an identifying unit configured to identify the at least three colors  
10 according to the color reference cells of the specified pattern portion;

a specifying unit configured to specify each color assigned to each of the unit cells according to the colors of the color reference cells and the at least three color image data; and

a decoding unit configured to decode the data value of each of the  
15 unit cells according to the specified color of each of the unit cells.

18. A reading apparatus according to claim 17, wherein said unit cells are partitioned into a plurality of blocks, said plurality of blocks include at least one data block representing data, and at least one error  
20 correcting block including an error correcting code for correcting an error caused in the at least one data block, said data of each of the blocks includes a data item that corresponds a combination of the colors assigned to the unit cells in each of the blocks, and an error detection code for detecting an error caused in the data item of each of the blocks,  
25 further comprising:

an error checking unit configured to check whether an error

occurs in the at least one data block according to the error detection code included in the data of the at least one data block; and

an error correcting unit configured to, when the error checking unit checks that the error occurs in the at least one data block, correct  
5 the error in the at least one data block according to the error correcting code in the at least one error correcting block.

19. A reading apparatus according to claim 17, wherein said identifying unit is configured to set at least three threshold brightness  
10 levels corresponding to the at least three colors, and said specifying unit is configured to determine whether brightness levels of the at least three color image data corresponding to each of the unit cells are higher than the set threshold brightness levels, respectively, and to specify each color assigned to each of the unit cells based on the result of the determination.

15

20. A displaying apparatus for displaying a two-dimensional code, in which said two-dimensional code comprising:

a plurality of unit cells arranged in two-dimension, each of said unit cells indicating one of at least three colors, each color of each of said  
20 unit cells being optically readable and representing a data value set to each of the unit cells, a set of all of the data values of the unit cells representing data; and

a specifying pattern portion including a plurality of color reference cells and configured to specify positions of the unit cells, and said color  
25 reference cells indicating all of the at least three colors, said displaying apparatus comprising:



a dividing unit configured to divide the data into a number of pieces of data;

a converting unit configured to convert the pieces of data into a number of two-dimensional code elements in a predetermined order, said  
5 number of two-dimensional code elements corresponding to the number of the pieces of data; and

a displaying unit configured to display switchably the two-dimensional code elements in the predetermined order.

10 21. A method of generating a two-dimensional code for representing data, said two-dimensional code comprising a plurality of blocks each including a plurality of unit cells, said method comprising:

dividing the data into a plurality of pieces of data, said pieces of data corresponding to the blocks, respectively;

15 computing a data value of each of the pieces of data;

assigning one of at least three colors to each of the unit cells of each of the blocks, each color of each of said unit cells being optically readable, a combination of said colors assigned to each of the blocks representing each of the computed data values;

20 arranging the colored blocks on a two-dimensional storage area in two-dimension; and

allocating a specifying pattern portion on the two-dimensional storage area at a position adjacent to the blocks so as to generate the two-dimensional code on the two-dimensional storage area, said  
25 specifying pattern including a plurality of color reference cells and configured to specify positions of the unit cells, said color reference cells

indicating all of the at least three colors.

22. A method of reading a two-dimensional code, in which said two-dimensional code comprising:

5 a plurality of unit cells arranged in two-dimension, each of said unit cells indicating one of at least three colors, each color of each of said unit cells being optically readable and representing a data value set to each of the unit cells; and

a specifying pattern portion including a plurality of color reference  
10 cells and configured to specify positions of the unit cells, said color reference cells indicating all of the at least three colors, said at least three colors having predetermined contrast levels to be optically identifiable thereamong, said method comprising:

reading out the two-dimensional code to generate at least three  
15 color image data corresponding to the at least three colors;

generating brightness image data comprising according to the at least three color image data, said brightness image data comprising at least two gray levels, one of which is higher than other thereof;

detecting the specified pattern portion according to the at least two  
20 gray levels included in the generated brightness image data;

identifying the at least three colors according to the color reference cells of the specified pattern portion;

specifying each color assigned to each of the unit cells according to the colors of the color reference cells and the at least three color image  
25 data; and

decoding the data value of each of the unit cells according to the

specified color of each of the unit cells.

23. A method of displaying a two-dimensional code, in which said two-dimensional code comprising:

5 a plurality of unit cells arranged in two-dimension, each of said unit cells indicating one of at least three colors, each color of each of said unit cells being optically readable and representing a data value set to each of the unit cells, a set of all of the data values of the unit cells representing data; and

10 a specifying pattern portion including a plurality of color reference cells and configured to specify positions of the unit cells, and said color reference cells indicating all of the at least three colors, said method comprising:

dividing the data into a number of pieces of data;

15 converting the pieces of data into a number of two-dimensional code elements in a predetermined order, said number of two-dimensional code elements corresponding to the number of the pieces of data; and

displaying switchably the two-dimensional code elements in the predetermined order.

20

24. A computer readable program product for generate a two-dimensional code for representing data, said two-dimensional code comprising a plurality of blocks each including a plurality of unit cells, said program product configured to cause a computer to:

25 divide the data into a plurality of pieces of data, said pieces of data corresponding to the blocks, respectively;

compute a data value of each of the pieces of data;  
assign one of at least three colors to each of the unit cells of each  
of the blocks, each color of each of said unit cells being optically readable,  
a combination of said colors assigned to each of the blocks representing  
5 each of the computed data values;

arrange the colored blocks on a two-dimensional storage area in  
two-dimension, said two-dimensional area being located in a memory,  
said computer being accessible to the memory; and

allocate a specifying pattern portion on the two-dimensional  
10 storage area at a position adjacent to the blocks so as to generate the  
two-dimensional code on the two-dimensional storage area, said  
specifying pattern including a plurality of color reference cells and  
configured to specify positions of the unit cells, said color reference cells  
indicating all of the at least three colors.

15

25. A computer readable program product for reading a  
two-dimensional code, in which said two-dimensional code comprising:

a plurality of unit cells arranged in two-dimension, each of said  
unit cells indicating one of at least three colors, each color of each of said  
20 unit cells being optically readable and representing a data value set to  
each of the unit cells; and

a specifying pattern portion including a plurality of color reference  
cells and configured to specify positions of the unit cells, said color  
reference cells indicating all of the at least three colors, said at least three  
25 colors having predetermined contrast levels to be optically identifiable  
thereamong, said program product configured to cause a computer to:

read out the two-dimensional code to generate at least three color image data corresponding to the at least three colors;

generate brightness image data according to the at least three color image data, said brightness image data comprising at least two gray levels, one of which is higher than other thereof;

detect the specified pattern portion according to the predetermined contrast level included in the generated brightness image data;

identify the at least three colors according to the color reference cells of the specified pattern portion;

specify each color assigned to each of the unit cells according to the colors of the color reference cells and the at least three color image data; and

decode the data value of each of the unit cells according to the specified color of each of the unit cells.

15

26. A computer readable program product for displaying a two-dimensional code, in which said two-dimensional code comprising:

a plurality of unit cells arranged in two-dimension, each of said unit cells indicating one of at least three colors, each color of each of said unit cells being optically readable and representing a data value set to each of the unit cells, a set of all of the data values of the unit cells representing data; and

a specifying pattern portion including a plurality of color reference cells and configured to specify positions of the unit cells, and said color reference cells indicating all of the at least three colors, said program product configured to cause a computer to:

divide the data into a number of pieces of data;

convert the pieces of data into a number of two-dimensional code elements in a predetermined order, said number of two-dimensional code elements corresponding to the number of the pieces of data; and

- 5        display switchably the two-dimensional code elements in the predetermined order.